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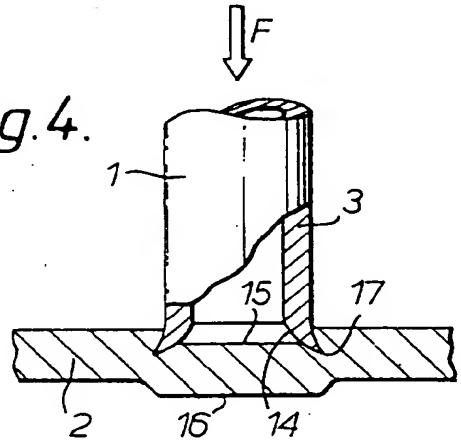
(54) Filter comprising a resonator rod mounted on a base plate.

(57) The invention relates to a filter, comprising a resonator rod formed by a metal tube (1) frictionally coupled to the base plate (2) of a resonator case, so that the metal tube is substantially perpendicular to the base plate (2). Frictional coupling removes the requirement for complex attachment means to secure the resonator rod (1) to the base plate (2) and enable preliminary tuning and ease of manufacture.

Fig.4.



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The invention relates to a filt r comprising a r sonator rod coupled to a metallic base plate.

A resonator such as a rod resonator or a coaxial resonator comprises a r sonator rod of conducting material, usually a copper tube with the outer surface plated with silver or a silver alloy, mounted in a metallic case so as not to contact the conducting surface of the case. One end of the resonator rod is mounted conductively to a wall of the case, and a small air gap is left between the other end and the wall of the case. The length of the resonator rod is substantially equal to a quarter of the wavelength corresponding to the frequency at which the resonator is desired to resonate. The construction in other words forms a quarter-wave resonator.

A signal can be supplied to the case and taken from it through inductive or capacitive coupling, and in practice-this is effected by introducing a suitable length of a coupling conductor into the resonator field. By placing several resonator rods in the same case an electromagnetic coupling is formed between the resonator rods, and a filter with desired characteristics can be obtained by utilizing the couplings. All rods in the filter can be mounted to the same wall of the case, wherein the filter is called a comb filter. In order to obtain sufficient coupling, the resonator rods are usually made slightly shorter than the desired quarter-wavelength, and at the free end of the rod there is placed a plate which considerably increases the capacitance of the rod. The resonator rod ends can also be mounted so that the end of every second resonator rod is mounted to a first wall and every other resonator rod is mounted to the wall opposite the first wall. This design is called an interdigital filter. With this construction the resonator rods can be located sufficiently close to each other to form the coupling, and it is not necessary to use capacitance increasing plates at the resonator rod ends. However, such a filter is expensive and difficult to manufacture.

A filter assembled of coaxial resonators is particularly useful at a frequency range extending from the VHF frequencies to rather low microwave frequencies, and particularly in such applications where small size and low weight are not absolute requirements.

The length of the resonator rods and the mechanical and electrical connection to the base plate are of critical importance in the production of a filter which will operate efficiently at the desired frequency. Therefore to date cumbersome mechanical fixing means have been used to attempt to produce a good mechanical and electrical connection and an accurate and constant resonator rod length.

Known filters have some considerable disadvantages. The filter is a component operating at high frequency and all conducting parts in its electromagnetic field will have an effect on its function. In filters where a bolt etc. is placed into the lower part of a r sonator rod, its influence must be observed while dimensioning the filter. The known filt rs further utilize a plurality of separate mounting parts, which requires additional work stages when the filter is assembled. A serious drawback of the pr sent filt r and the required mounting methods can also be that no preliminary tuning of the resonator frequency is possible.

According to the present invention there is provided a filter comprising a resonator rod mounted in a substantially upright position on a base plate, **characterized** in that the resonator is frictionally coupled to the base plate.

The present invention provides many advantages compared to known filters including: preliminary tunability; reliability; speed of manufacture and economy, as far fewer tools and components are needed in its manufacture. By controlling the length of the rod, for example by controlling the depth which the rod is pressed into the base plate it is possible to provide preliminary tuning of the high frequency filter, because even a small change in the pressing depth will have a substantial effect on the electrical length of the rod. The invention can be applied both in the case of a single resonator and in a high frequency filter, which has several resonator rods on a common base plate.

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 shows a known filter comprising a resonator rod coupled to a base plate in a known manner;

Figure 2 shows another known filter;

Figure 3A shows a resonator rod in accordance with a first embodiment the present invention;

Figure 3B shows a base plate, without deformation and another with a depression in accordance with the first embodiment of the present invention;

Figure 4 shows the resonator rod of Fig. 3A coupled to the base plate of Fig. 3B;

Figure 5 shows a second embodiment of the present invention; and

Figure 6 shows a third embodiment of the present invention.

In the known filters the most cumbersome manufacturing step is to mount the resonator rod 1 to the wall of the case. Usually the resonator rods 1 are mounted on a separate plate, whereafter the construction is enclosed in a metal case. In the following this plate is called the base plate 2. At least two basic ways are known to mount the resonator rod 1 on the base plate 2. In Figure 1 the resonator rod 1 is mounted to the metallic base plate 2 in which there is formed a receiving hole with a diameter slightly smaller than that of the resonator rod 1 and with sides bevelled to form a frusto-conical op ning. A corresponding external b v l 5 is formed at the lower end of the

r sonator rod 1. Screw threads 4 are made at the inner surface of th resonator rod 1. Now th resonator rod 1 is mounted to the bas plate 2 so that the resonator rod 1 is placed into the hole in the base plate 2, whereby the external bevelled surface 5 of the resonator rod 1 and the base plate 2 will abut. From below a bolt 6 is inserted in the resonator rod 1, the bolt engaging the threads 4 and tightening the rod 1 securely to the base plate 2. A washer 7 is used under the bolt-head.

In Figure 2, where the same reference numerals as in Figure 1 are used where applicable, another mounting means is illustrated in which a bevel 5 is made in the resonator rod 1 and a hole is formed in the base plate 2, in a similar way as above. A disk-like part 9 with a diameter slightly smaller than the inner diameter of the resistor rod 1 is inserted in to the resistor rod 1 before the resistor rod 1 is mounted. The disk-like part 9 has a central hole into which a pin 11 is inserted. The other end of the pin 11 has threads 13 over a part of its length. When the disk 9 and the pin 11 are placed inside the resistor rod 1 the outer rod surface is compressed at the location of the disk 9, which results in a crimp joint between the rod 1, the disk 9 and the pin 11. Then the resistor rod 1 is placed in the hole of the base plate 2 so that the bevels of the resistor rod 1 abut the bevels of the base plate 2. The pin 11 extends somewhat outside on the opposite side of the base plate to receive a washer 7. A nut 12 is screwed onto the pin 11, which provides a mechanically reliable mounting of the resonator rod 1 to the base plate 2.

Figure 3A shows the shape of the end of a resonator rod 1 to be used in one embodiment of the invention. An internally bevelled surface 14 is formed in the wall 3 of the rod 1, whereby a knife edge 17 is formed at the junction between the bevelled surface and the wall. The steepness of the bevel is not so great that the material of the edge 17 could break during a coupling step.

Figure 3B shows bowl-like recess 15 on the top surface of the base plate 2, the diameter of the recess corresponding substantially to the outer diameter of the rod 1. During the step of making the recess 15 there is formed a bowl-like boss of a corresponding size on the opposite side of the plate. The depth of the recess 15 can be selected as desired. The depth of the recess will have an effect on the electrical characteristics of the resonator, as will be described later. Another purpose of the recess is to function as an aid when the resonator rod 1 is positioned on the base plate.

During a pressing step in the assembly process the rod 1 is placed with the bevelled surface into the recess 15, whereby the resonator rod 1 is accurately positioned substantially perpendicular to the direction of the base plate 2.

The positioning is important particularly when s veral resonator rods are placed on the same base plate when the filter is manufactured.

After positioning a pressing force F is applied to th r sistor rod 1, the direction of the force being along the axis of th rod and perpendicular to the plate 2 (see Fig. 4) . Due to the pressing action the edges 17 of the resonator rod 1 will sink into the material of the base plate 2, whereby they are forged into a frictional contact and will at the same time bend slightly outwards. Thereby a very good mechanical and electrical joint is provided between the rod resonator and the base plate 2 in a fast and simple way. This was not possible with the known filter resonator rods which are either not bevelled or externally bevelled and would therefore not deform. By changing the depth of the recess 15 and the pressing force F it is possible to have an effect on the sinking depth of the rod 1 and thus on its electrical length, and therefore it is possible to provide preliminary tuning of the filter in this step. The method of manufacture of the filter can also be realized using the conventional base plate, in which no recesses are made, as shown in the top of figure 3B.

Figure 5 shows another embodiment. Here no preliminary measures need be taken regarding the resistor rod 1, which can be left unbevelled. Instead a pressing force is applied to the base plate 2 on a circular region, the diameter of which approximately corresponds to the internal diameter of the resistor rod 1, being slightly larger than said internal diameter. As a result of the pressing there is formed a cylindrical boss 18 with a desired height on the surface of the plate 2. The resistor rod 1 may be pressed onto the boss 18, which penetrates into the resistor rod 1 and is tightly frictionally secured to its internal wall.

Figure 6 shows a third embodiment of the filter, in which the resonator rod 1 comprises a bevelled surface 19 inside the end of the rod 1, whereby a tapering point region 21 is formed between the bevelled surface and the outer wall of the resonator rod 1. The base plate 2 is provided with a hole, formed so as to slidably receive the rod and in which the resonator rod 1 is inserted so that the point region will extend slightly through the bottom surface of the base plate 2. Then a conical plug 20, made of e.g. metal is inserted into the lower part of the resonator rod 1 and forged into the resonator rod 1 the plug 20 abutting the bevelled surface 19 and force its point region 21 to bend, so that the lower edge of the rod 1 will spread sidewards. At the same time the narrower top part of the plug 20 will press the wall 3 of the resonator rod 1 against the edge of the hole. Thus an acceptable electrical and mechanical joint between the rod 1 and the base plate 2 is created in a simple work stage.

In all of the aforementioned embodiments the filters can be manufactured in a single work stage. Also preliminary tuning can be carried out by varying the length of the resonator rod 1 with respect to the base

plate 2.

In view of the for going description it will be evident to a person skilled in the art that modifications and improvement may be incorporated without departing from the scop of the present invention.

Claims

1. A filter comprising a resonator rod mounted in a substantially upright position on a base plate, **characterized** in that the resonator is frictionally coupled to the base plate.

2. A filter as claimed in claim 1, wherein one end of the resonator rod is provided with a weaker portion configured to deform outwards under a force applied substantially axially along the resonator rod, in order to engage the base plate.

3. A filter as claimed in claim 2, wherein the weaker portion comprises an internal bevelled surface.

4. A filter as claimed in claim 3 wherein the internal bevelled surface is configured as a knife edge.

5. A filter as claimed in any of the preceding claims, wherein the base plate comprises a depression formed to receive the resonator rod.

6. A filter as claimed in claim 1, wherein the base plate comprises a boss adapted to frictionally receive and locate the resonator rod.

7. A filter as claimed in claim 6, wherein the boss is formed integrally with the base plate.

8. A filter as claimed in any of claims 1 to 3, wherein the filter further comprises a retaining plug, and wherein the base plate comprises an aperture formed to slidably receive the resonator rod; the retaining plug being adapted so that on insertion into the resonator rod the retaining plug will urge the resonator rod outwards into frictional engagement with the base plate.

9. A filter as claimed in any of the preceding claims, wherein the resonator rod is disposed substantially perpendicular to the base plate.

Fig.1.

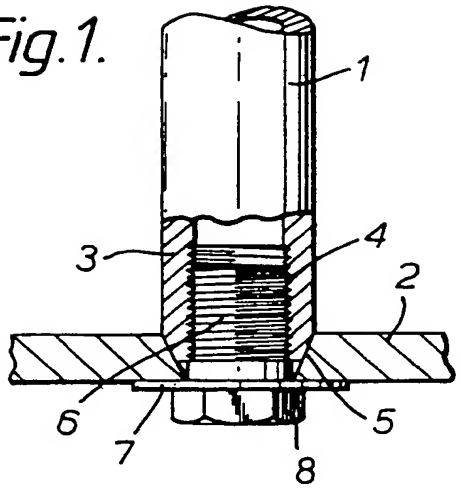


Fig.2.

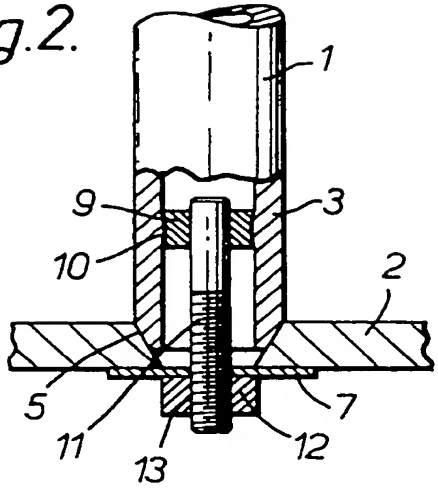


Fig.3A

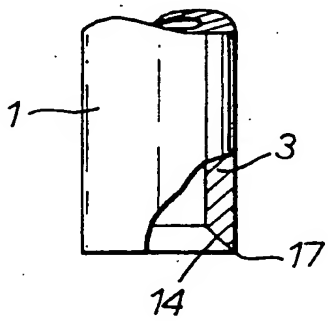


Fig.3B

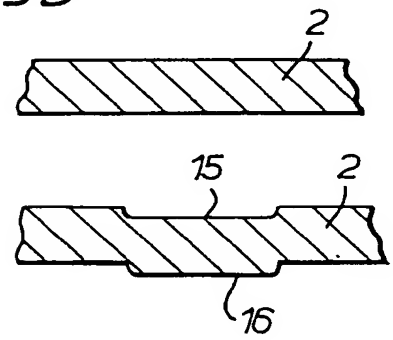


Fig.4.

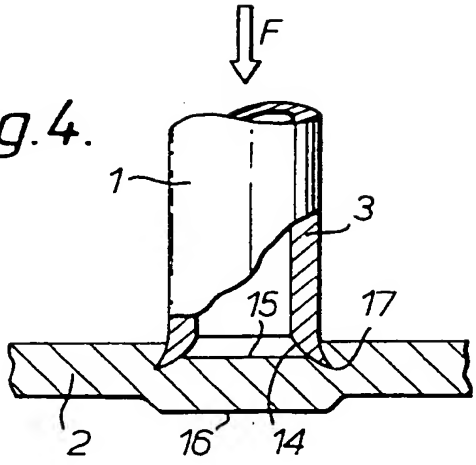


Fig.5.

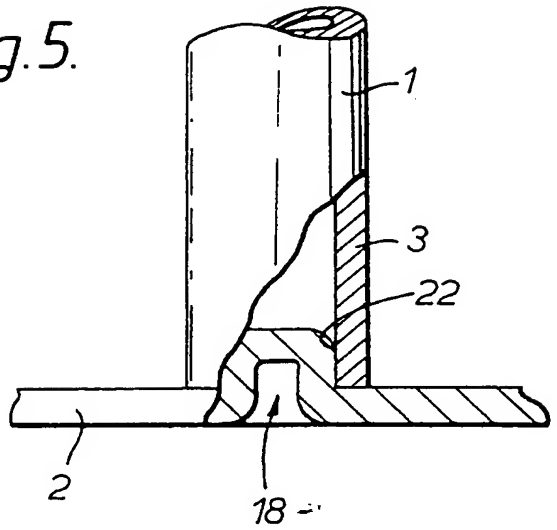
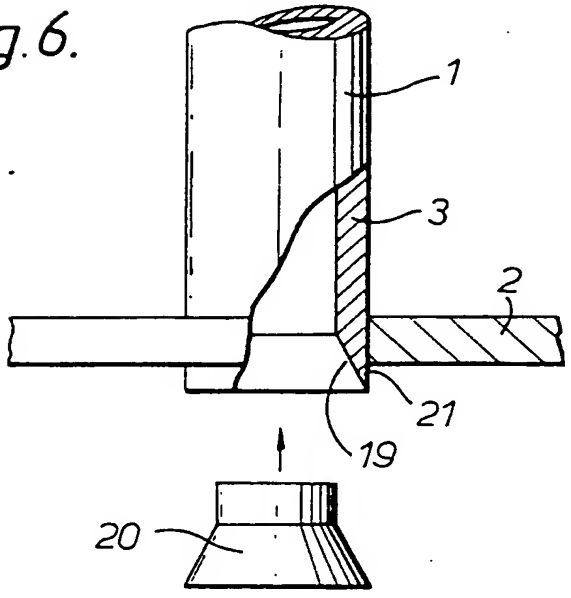


Fig.6.



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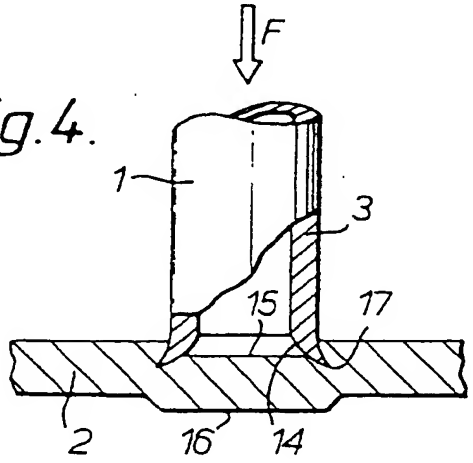

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EUROPEAN SEARCH REPORT

Application Number EP 92308214.3

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	US - A - 4 376 923 (CURTINOT et al.) * Fig. 1,2; abstract; column 1, lines 5-38 * --	1,7	H 01 P 7/06 H 01 P 1/205
X	US - A - 4 112 398 (BURNETT et al.) * Fig. 2; column 3, lines 12-24 * --	1,7	
A	US - A - 4 736 173 (BASIL, JR. et al.) * Fig. 4; abstract * ----	1,7	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

H 01 P 1/00
H 01 P 7/00

The present search report has been drawn up for all claims

Place of Search	Date of completion of the search	Examiner
VIENNA	21-03-1994	BERGER

CATEGORY OF CITED DOCUMENTS

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